# Technical Assistance Services *for* Communities
# DePue/New Jersey Zinc/Mobil Chemical Corp. Superfund Site
# Review of November 2018 Technical Memorandum: In-Situ Caged Fingernail Clam Study Results

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## Introduction

In November 2018, the DePue Community Advisory Group (CAG) requested support from the U.S. Environmental Protection Agency's (USEPA's) Technical Assistance Services for Communities (TASC) program. The CAG requested that TASC conduct a review of the Operable Unit 5 Technical Memorandum: In-Situ Caged Fingernail Clam (FNC) Study (Memorandum).

Independent technical and environmental consultants implement the TASC program. The report's contents do not necessarily reflect the policies, actions or positions of USEPA. TASC prepared this review report for the DePue Superfund CAG.

## General Response

The FNC study was designed to assess mortality as the only indicator of potential site-related impacts, and the pilot study work plan stated multiple times that a lack of FNC mortality would indicate site-related contamination is not impacting the FNC population. The CAG and previous TASC comments expressed concerns at the lack of assessment for sub-lethal effects as well as whether the overall study design was adequate to assess lethal effects. Ultimately, Illinois EPA (IEPA) allowed the potentially responsible party (PRP) to proceed with the study as designed, with the understanding that FNC mortality in DePue Lake as compared to Goose Lake would be the measure of site-related impacts.

The extent of FNC mortality in DePue Lake provides clear evidence of acute toxicity in DePue Lake. Sampling data indicate site-related metals contamination at significantly higher concentrations of several metals. Therefore, TASC does not agree with the definitiveness of the

conclusions drawn in the Memorandum that zinc is not considered a potential stressor and that only ammonia and dissolved oxygen are potential stressors.

While the data do indicate the influence of several potential stressors, TASC believes the report over-emphasizes the potential impact of non-site related stressors (i.e., ammonia and dissolved oxygen) and discounts the potential impact of site-related metals contamination. It is unclear from the report what next steps the PRP proposes or what IEPA intends to require. Overall, TASC believes the findings do not provide definitive evidence of no site-related impacts or a clear conclusion regarding the previously noted lack of FNC in DePue Lake.

TASC recommends the CAG request further investigations into the causes of the lack of FNC in DePue Lake and the mortality observed in the 2018 study.

**Sub-Lethal Effects**
The Memorandum includes many statements and references to the sub-lethal effects of various stressors. Notably, the report states the following regarding zinc toxicity:

*"Laboratory research has indicated that zinc may adversely affect FNC, and exposure produced a statistically significant reduction in the ciliary beating rate of gills in large FNC (Anderson et al. 1978, Sparks et al. 1981), and gills from large clams generally were several orders of magnitude more sensitive than gills from small clams (Anderson et al. 1978). Surface water zinc exposures of greater than 0.05 mg/L significantly reduced total weight gain in juvenile and adult Asiatic clams (Belanger et al. 1986)."*

During the Pilot Study and development of the Work Plan, the CAG provided comments to IEPA regarding the significance of sub-lethal effects and that, by measuring only mortality, the FNC study could incorrectly conclude that FNC are not affected by site-related contamination. Although FNC ultimately did suffer high mortality rates, the concern for sub-lethal effects remains valid.

TASC Comment: TASC suggests the CAG request that IEPA proceeds with a conservative approach regarding zinc toxicity due to, as noted by the PRP, the potential sub-lethal effects on FNCs.

**Bioavailability**
As noted previously by TASC, there are several potential challenges associated with using simultaneously extracted metals/acid-volatile sulfide (SEM-AVS) to assess bioavailability of metals at the Site:

- There are many variabilities observed in results obtained in the field.
- Bioavailability data have inherent uncertainty.
- Bioavailability data only determine if contaminants are toxic during short-term exposure.
- Since animals will be exposed to sediment contamination over long periods, bioavailability values may underestimate actual impacts.

Due to the high mortality rates, the 2018 study did not include analysis of FNC tissue samples. The study and IEPA approach are based on assessing multiple lines of evidence, and the inclusion of tissue analyses would be of particular value given the Memorandum's conclusion that zinc and other metals did not cause the observed mortality.

Although the data do not point to the high-risk category, it is premature to conclude there is no potential for bioavailable metals and uptake. The Memorandum findings indicate five of 10 samples are within the Category 1 – Low Risk and five of 10 samples are within Category 2 – Uncertain Range according to EPA guidance. According to the guidance document in the Memorandum, chronic effects were observed in six of the seven sediments where predictions of effects are Category 2 – Uncertain. The guidance states that chronic toxicity tests with sensitive benthic species will be a necessary part of the evaluations of sediments predicted to have uncertain effects.

TASC Comment: TASC recommends that the CAG request that any further investigations into FNCs in DePue Lake include tissue analyses for zinc and other site-related metals. Alternatively, other organisms more readily found in DePue Lake could be harvested for tissue analysis and further assessment of bioavailability. Although tissue analysis is not the sole data point to indicate that site-related contamination is the cause of the lack of FNC in DePue Lake or the cause of observed mortality, the data will confirm whether the metals are available to FNC.

**Use of Benchmarks and Modeling**

The Memorandum includes extensive discussion of statistical analyses and comparisons to benchmarks outside of the intent of the FNC study. Notably, the Memorandum states:

*Based on the graphical and correlational analysis performed for bulk sediment and sediment porewater parameters in comparison to live FNC counts for DePue Lake, no significant correlations exist between the number of live FNC and any of the parameters measured in sediment or sediment porewater (Table 7-7).*

While it is understandable the near-complete mortality of FNCs in DePue Lake affected the statistics employed in the study, TASC does not consider the use of regression analysis on the 10 surviving clams < 6 millimeters in length (Section 7.2.2 and Table 7-7) to be appropriate, or to consider the lack of correlation as a line of evidence against the effects of site-related contamination in sediment.

TASC Comment: TASC suggests the CAG confirm if IEPA considers these analyses to be lines of evidence meriting inclusion in its assessment of the FNC study findings. As noted previously by IEPA, risks must be adequately characterized, particularly in areas where the metals in sediment, bioavailability and toxicity test data do not align to present a definitive picture of the potential risk.

**Potential Stressors**
In the below section, TASC presents the Memorandum summary conclusions regarding zinc, ammonia and dissolved oxygen (DO), and includes notes and comments.

***Zinc***

- Although total (undissolved) zinc was detected in each of the surface water samples from all three lakes, dissolved zinc was only detected in two of 15 DePue Lake surface water samples (and one surface water sample from Goose Lake).
- The two detected dissolved zinc concentrations from DePue Lake surface water samples were below the screening benchmarks.
    - TASC notes the screening benchmarks are generic benchmarks and do not account for FNC as a sensitive species.
- The detected dissolved zinc concentrations in DePue Lake surface water were over several orders of magnitude lower than the paired biotic ligand model (BLM)-predicted acute and chronic LC50. In addition, dissolved zinc concentrations in DePue Lake surface water were over several orders of magnitude lower than the paired BLM-predicted acute and chronic HC5 values [fifth percentile for species sensitivity distribution (SSD) toxicity values].
    - TASC notes the BLM-predicted concentrations are based on trout, minnow and daphnia. The Memorandum correctly states: "*These are the only species currently included in the HydroQual BLM for zinc, and therefore are used as a surrogate for FNC*." Therefore, this approach does not reflect FNC as a sensitive species.
- The (ΣSEM-AVS)/foc data for DePue Lake result in six of 10 samples as Category 1 (low risk) and four of 10 samples as Category 2 (uncertain range). None of the samples are Category 3 (expected biological effects).
    - TASC notes that, as noted above, according to the cited guidance, Category 2 – Uncertain Range warrants additional investigation
- There was no statistically significant difference ($p<0.05$) in Σ(SEM-AVS)/foc values for DePue Lake and Goose Lake.
- Conclusion: Zinc is not considered a potential stressor to FNC.
    - TASC suggests that this conclusion is premature. Although the data presented do not strongly suggest zinc as the cause of the high mortality rates in the study, it remains a potential stressor warranting further investigation. In particular, the question of bioavailability and uptake remains unanswered due to the lack of tissue mass to allow for analysis.

***Other Metals (Besides Zinc)***

- Although total (undissolved) metals were detected in each of the surface water samples, dissolved metals were detected less frequently and limited to arsenic, cadmium and nickel.
- Total metals concentrations of cadmium and copper are statistically significantly higher ($p<0.05$) in DePue Lake compared to Goose Lake. For sediment, concentrations of arsenic, cadmium, chromium, copper, lead, mercury and nickel are statistically significantly higher ($p<0.05$) for DePue Lake compared to Goose Lake.
- All dissolved metals concentrations in surface water are below criteria.

    - TASC notes the screening benchmarks are generic benchmarks and do not account for FNC as a sensitive species.
- For sediment, the only probable effect concentration (PEC) exceedance is for cadmium (eight of 10 samples).
    - TASC notes that IEPA has previously stated it will not rely solely on PEC as a benchmark in decision-making.
- The (ΣSEM-AVS)/foc data for DePue Lake result in five of 10 samples as Category 1 (low risk) and five of 10 samples are Category 2 (uncertain range). None of the samples are Category 3 (expected biological effects).
    - TASC notes that, as noted above, according to the cited guidance, Category 2 – Uncertain Range warrants additional investigation.
- There is no significant difference in Σ(SEM-AVS)/foc values for DePue Lake and Goose Lake.
- Conclusion: Other non-zinc metals are not considered potential stressors to FNC.
    - TASC suggests that this conclusion is premature. Although the data presented do not strongly suggest other metals as the cause of the high mortality rates in the study, it remains a potential stressor warranting further investigation. In particular, the question of bioavailability and uptake remains unanswered due to the lack of tissue mass to allow for analysis.

***Ammonia***

- Surface water and porewater ammonia concentrations were statistically significantly higher ($p<0.05$) in DePue Lake compared to Goose Lake.
- Although DePue Lake surface water and sediment porewater total ammonia as nitrogen (TAN) concentrations frequently exceeded the IEPA (2018) and USEPA (2013) chronic and acute criteria, including criteria specific to bivalves, the values were below toxicity values from the literature specific to FNC.
    - TASC notes that use of bivalve-specific criteria is of value. However, use of bivalve-specific criteria for ammonia only biases the lines of evidence and the Memorandum's conclusion that ammonia is of concern.
- Earlier research attributed the regional decline in FNC throughout the Illinois River to concentrations of unionized ammonia (Sparks and Sandusky 1981; Sparks and Blodgett 1983; Sparks et al. 1992). As such, it is recognized that FNC in the Illinois River (and DePue Lake) can be affected by elevated levels of ammonia.
    - TASC notes the Memorandum also cites scientific literature documenting the sub-lethal effects of metals on FNC. As such, the Memorandum's emphasis on this ammonia literature suggests the zinc and non-zinc metal literature is of equal merit and should be considered as lines of evidence and cause for a conservative interpretation of the site data.
- Conclusion: Elevated ammonia is identified as a potential stressor to FNC. The level of confidence is considered low to medium given the potential toxicity of ammonia and the frequency and magnitude of criteria exceedances, and the recognition that concentrations are below levels that have been identified as acutely toxic to FNC.
    - TASC notes that ammonia is a potential stressor to FNC.

***Low Dissolved Oxygen***

- The DO values recorded by the sondes indicate that DO levels in DePue Lake surface water were statistically significantly lower ($p<0.05$) than Goose Lake. Periods of low DO have also been previously documented for DePue Lake (Arcadis 2015).
- DO measures in DePue Lake were frequently below the USEPA (2004) acute daily minimum DO criterion of 3.0 milligrams per liter, or mg/L (257 of 1,907 measurements, or approximately 13 percent) and below the IEPA (2018) acute daily minimum DO criterion of 3.5 mg/L (328 of 1,907 measurements, or approximately 17 percent).
    - TASC notes that these criteria are based on sub-lethal effects. As such, these are not LC50 criteria and not appropriate to attribute as the cause of the extent of mortality as observed in the 2018 study.
- FNC are known to be affected by conditions of low DO in surface water.
    - As noted in the Memorandum, DO is important for aquatic organisms. However, the intent of the FNC study is to understand why there is a specific lack of FNC in DePue Lake. Although FNC are expected to be affected by low DO, as are other aquatic organisms, this was not an observation during prior investigations.
- Conclusion: Periods of low DO are considered a potential stressor to FNC. There is a relatively high level of confidence given the potential harmful effects of low DO on FNC and the frequency and magnitude of DO values below the minimum DO criteria.
    - TASC notes that low DO is a potential stressor to FNC. However, the low DO observed in the 2018 study does not explain the previously observed paucity of FNC in Lake DePue, which is the ultimate intent of the FNC study. It remains possible the periods of low DO are not significant enough to cause the extensive mortality observed in the 2018 study. In addition, it is not possible to attribute the 2018 data to prior years. Notably, the 2017 FNC pilot study illustrated that FNC can survive and grow in the placed cages.

**TASC Contact Information**

Project Manager
Tiffany Reed
847-786-8767
treed@skeo.com

Technical Advisor
Ryan Burdge
434-233-4642
rburdge@skeo.com

Task Order Manager
Emily Chi
541-238-7516
echi@skeo.com

Senior Program Manager
Eric Marsh
817-752-3485
emarsh@skeo.com

Skeo Vice President, Director of Finance and Contracts
Briana Branham
434-226-4284
bbranham@skeo.com

TASC Quality Control Monitor
Bruce Engelbert
703-953-6675
bengelbert@skeo.com